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# PLAN FOR CONDUCTING PILOT COLUMN TESTING AT THE ST. LOUIS PARK GAC PLANT

# PLAN FOR CONDUCTING
# PILOT COLUMN TESTING
# AT THE
# ST. LOUIS PARK GAC PLANT

Prepared by
Reilly Tar & Chemical Corporation

March 17, 1988

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## BACKGROUND

The granular activated carbon (GAC) treatment plant at St. Louis Park wells 10 and 15 started operation on July 9, 1986. The plant operated uneventfully through the spring of 1987.
Samples of treated water collected on May 26 showed breakthrough above the advisory level of 175 ng/l for noncarcinogenic PAH (total PAH concentrations of 160, 259 and 285 ng/l for triplicate samples). This was confirmed by samples collected June 16 (207, 454 and 700 ng/l total PAH for triplicate samples). In response to these results, the City took the plant off line on June 25. Subsequent testing pursuant to RAP Section 4.6 (requiring 4 to 6 successive days of sampling) on two separate occasions (June 29 to July 2 and July 28 to August 1) gave average results below the drinking water criterion of 280 ng/l for noncarcinogenic PAH. Nonetheless, Reilly offered to replace the carbon, which was done in early August.

The GAC plant began operation with its second load of carbon on August 12. Treated water samples collected on November 24 showed breakthrough above the advisory level (198 and 224 ng/l total PAH for duplicate samples analyzed by ERT, and 112 and 310 ng/l for duplicates by CH2M Hill). This was confirmed by CH2M Hill's results for duplicate samples collected on December 21 (209 and 211 ng/l). However, ERT's results for January 11, 1988 samples and CH2M Hill's results for January 20 samples both showed total PAH concentrations back down below 100 ng/l. The City has continued to operate the plant and monitor the treated water in accordance with RAP requirements, since the drinking water criteria have not been exceeded. During both carbon cycles the breakthrough problem has only involved noncarcinogenic PAH;

concentrations of carcinogenic PAH in treated water samples have been non-detectable or well below the drinking water criteria.

Despite the significant difference in the run lengths from startup to breakthrough (321 vs. 104 days), the GAC plant has performed consistently during both runs when changes in feed water quality and flow rate are considered. In both cases, the plant has removed about 0.00016 lb. PAH per lb. carbon (see Table 1). However, this carbon capacity (and hence carbon life) is considerably less than that predicted by Calgon and CH2M Hill for their conceptual designs. Calgon estimated a carbon capacity of 0.0033 lb/lb (Calgon, 1984) based on isotherm testing by CH2M Hill (CH2M Hill, 1982), while CH2M Hill estimated a capacity range of 0.0004 lb/lb to 0.002 lb/lb (CH2M Hill, 1983) based on a 42-day pilot column test (ibid.) and their isotherm testing (op. cit.). Calgon also performed an Accelerated Column Test and concluded that the carbon use rate should be less than 0.05 lb per 1000 gal (Calgon, 1985), which is equivalent to a capacity of greater than 0.0017 lb/lb at a feed PAH concentration of 10 ug/l (Calgon, 1985).

Calgon Carbon Corp. has indicated in recent discussions that there are three possible explanations for the considerable difference between actual and predicted carbon utilization rates, viz.:

1) There has been a significant shift in the molecular weight profile of PAH in the well water towards lower molecular-weight compounds between samples used for testing and the feed delivered to the full-scale GAC plant. These lower molecular weight PAHs, which have weaker adsorption characteristics than higher molecular weight PAH, determine the occurrence of initial breakthrough.

TABLE 1
CARBON PERFORMANCE
DURING FIRST TWO CYCLES

| ITEM | FIRST CYCLE | SECOND CYCLE |
|---|---|---|
| 1. Startup date | 7/9/86 | 8/12/87 |
| 2. Date of first breakthrough[a] | 5/26/87 | 11/24/87 |
| 3. No. of days on line | 321 | 104 |
| 4. Total pumpage, millions of gallons[b] | 214 | 116 |
| 5. Average flow rate, gpm | 463 | 775 |
| 6. Avg. PAH concen. in feed, ug/l | 3.6[c] | 7.1[d] |
| 7. PAH in feed, start to breakthrough, lbs. | 6.4 | 6.9 |
| 8. Carbon use rate, lb PAH/lb GAC | 0.00016 | 0.00017 |

NOTES:

(a) Date of sample collection for first samples showing effluent concentrations greater than the advisory level (175 ng/l).

(b) From City pumpage records.

(c) Average of 7/15/86, 7/30/86, 10/7/86, 3/17/87 and 6/16/87 sample results by ERT and 8/26/86 result by CH2M Hill.

(d) Average of 6/16/87 and 9/15/87 sample results by ERT and and 12/21/87 sample result by CH2M Hill.

2) There has been a significant shift in the relative proportions of naturally occurring TOC and the PAH contaminants in the well water between the various testing samples and the actual full-scale feed water. Moreover, the natural TOC, which is present at about 3 mg/l (CH2M Hill 1983, ERT 1983) dominates the trace PAH constituents in determining carbon use rates.

3) The current pattern of controlling feed rates to the GAC plant (daily on-off cycles at full capacity or no flow) is causing the mass transfer zone at the front of the adsorption wave to spread out, yielding earlier breakthrough compared to steady operation at a constant rate.

Comparing the historical data for bench and pilot testing feeds (Calgon 1985, CH2M Hill 1982 & 1983, ERT 1983) with data from the full-scale operation indicates no significant shift in molecular weight profiles. However, there are no data available at this time to test hypotheses 2 and 3.

## OBJECTIVE

The objective of the plan presented here is to perform testing with the pilot-scale carbon columns at the GAC plant in parallel with operation of the full-scale system in order to determine 1) the effects of the current operating pattern on the carbon life and 2) the effect of natural TOC constituents on PAH adsorption. These objectives will be achieved by starting the pilot columns at the same time as the third carbon load in the full-scale adsorbers, running the pilot columns at a constant flow rate proportional to the expected rate for the full-scale system, and testing intermediate effluents from the pilot columns at a schedule designed to track the movement of the PAH and TOC adsorption fronts through the columns.

## APPROACH

Figure 1 is a schematic flowsheet for the pilot columns for the proposed test. Note that a storage tank, pump and flow indicator/recorder need to be added to the existing equipment. The storage tank is required in order to provide a constant feed rate to the pilot columns, since the wells feeding the main 8" feed water line are shut down after the GAC plant has treated the desired amount of water for the day.

Table 2 compares the dimensions of the pilot and full-scale carbon columns. The table also shows that operating three pilot columns in series at a flow rate of 0.45 gpm will mimic full-scale operation at a rate of about 816 gpm (i.e., both involve a 9-foot long carbon bed loaded at 5.2 $gpm/ft^2$). This flow rate is expected to approximate actual operation of the full-scale plant by the City during late spring/early summer, based on operating rates for 1987 (i.e., 592, 827 and 824 gpm average flow rates for April, May and June 1987, respectively). The 0.45 gpm flow rate for the pilot column is also close to the rate used during CH2M Hill's 42-day pilot test (i.e., 0.44 gpm in 4-inch diameter columns -- CH2M Hill, 1983).

The predicted breakthrough time for a single 3-foot pilot column tested at 0.45 gpm is 23 to 32 days, based on the carbon capacities shown in Table 1 and feed concentrations of 7 to 10 ug/l total PAH (reflecting ERT's 9/15/87 and CH2M Hill's 12/21/87 feed sample results, respectively). The sampling schedule shown in Figure 2 is intended to track the movement of PAH and TOC through the pilot columns based on

FIGURE 1
SCHEMATIC FLOW DIAGRAM FOR
PILOT COLUMN TESTING

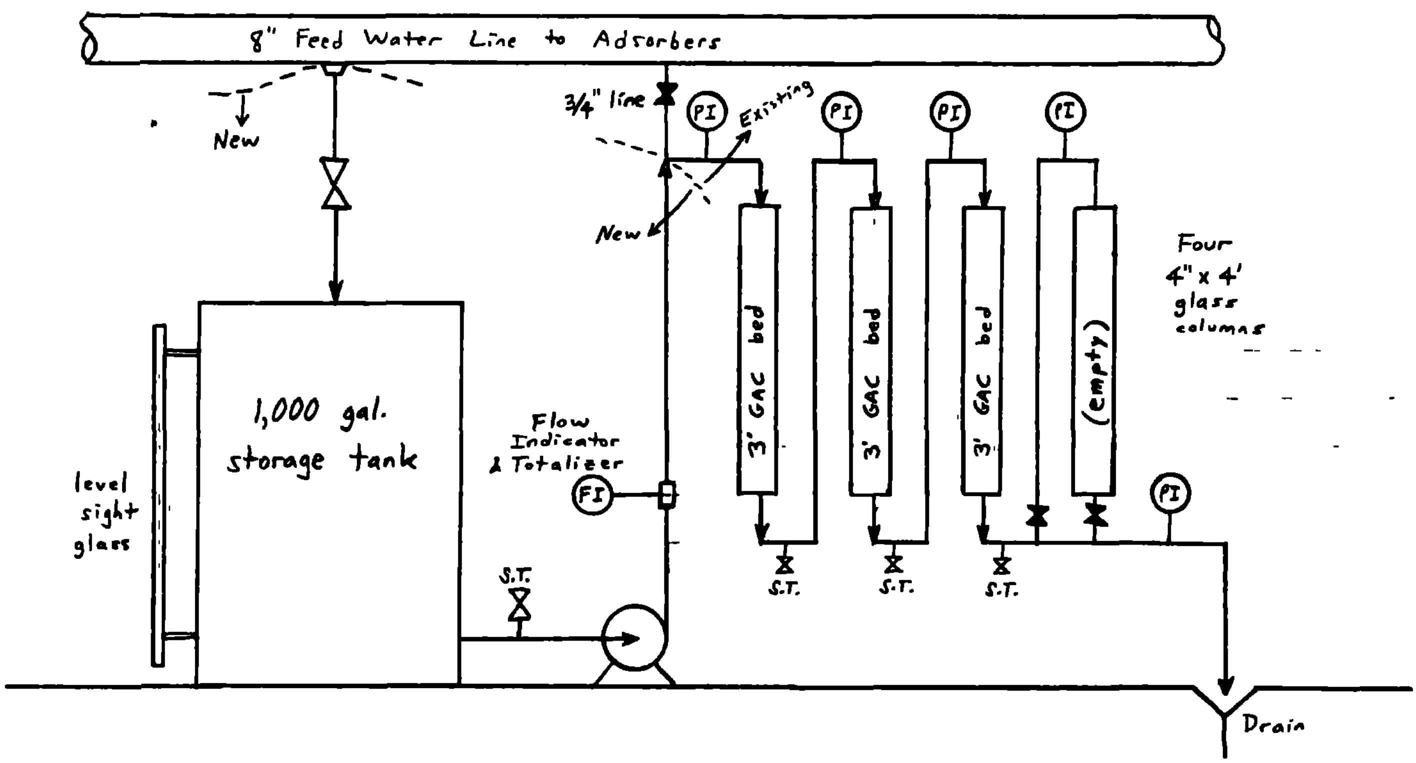
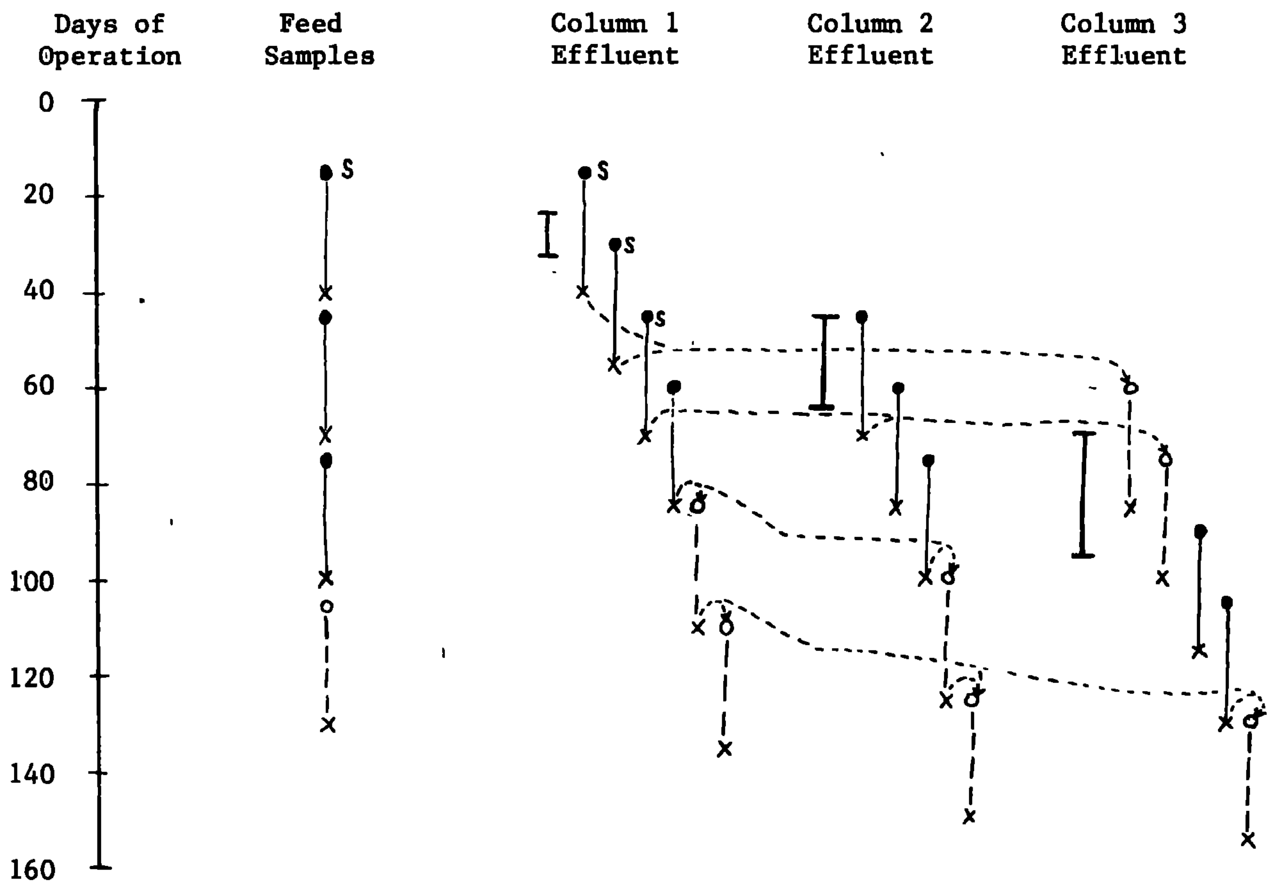


**TABLE 2**
**CARBON COLUMN CHARACTERISTICS**
**FOR FULL-SCALE VS. PILOT COLUMNS**

| ITEM | PILOT COLUMNS | FULL-SCALE COLUMNS | | |
|---|---|---|---|---|
| Configuration | 3 in series | 2 in parallel | | |
| Dimensions of each column: | | | | |
| - diameter, ft | 0.33 | 10.0 | | |
| - bed depth, ft | 3 | 9 | | |
| - cross-sectional area, $ft^2$ | 0.087 | 78.5 | | |
| - bed volume, $ft^3$ | 0.26 | 707 | | |
| - carbon weight, lbs. | 7.4 | 20,000 | | |
| Operating parameters at specified rates: | | | | |
| - flow rate, gpm | 0.45 | 600 | 800 | 1200 |
| - hydraulic loading rate, $gpm/ft^2$ | 5.2 | 3.8 | 5.1 | 7.6 |
| - empty bed contact time, min. | 13.0 | 17.6 | 13.2 | 8.8 |

FIGURE 2

SAMPLING SCHEDULE
FOR PILOT COLUMN TESTING




| No. of Samples: | Feed Samples | Column 1 Effluent | Column 2 Effluent | Column 3 Effluent |
|---|---|---|---|---|
| Definite | 4 | 7 | 3 | 2 |
| Contingent | 1 | 2 | 2 | 3 |

LEGEND:

- ● Sample collected
- o Contingent sample collection
- X Results received (assuming 25-day turnaround)
- I Predicted range for start of breakthrough
- ∿ Triggering result(s) for contingent sampling
- S Split sample to ERT lab

NOTE: All samples to be analyzed for PAH and TOC by the RMA lab.

this predicted breakthrough time. Note that the sampling schedule calls for collection of samples later in the test being contingent on results observed from earlier samples. The decisions on whether and when to collect contingent samples will be made by Reilly and Calgon in consultation with EPA, MPCA and City Project Leaders. Also note that all samples will be analyzed for TOC and PAH by Enseco/RMA Laboratory, with splits of selected early samples to be analyzed by ERT's laboratory.

## TEST PROCEDURES

### Equipment Installation

The new equipment indicated in Figure 1 will be installed by a general contractor hired by Reilly Tar & Chemical Corporation. The specifications for this work are provided in Appendix A. The work will be performed under the direction of Reilly's Engineering Department, with final inspection and approval by the City of St. Louis Park.

The equipment specifications in Appendix A call for a peristaltic pump and a 6-foot diameter by 5-foot high fiberglass tank. A peristaltic pump has been specified to minimize the chance of contaminating the feed water with pump lubrication constituents. The fiberglass tank will be post-cured with steam to minimize leaching of plasticizers into the feed water. The fiberglass should be adequately inert with respect to adsorptive losses of PAH given the high volume to surface area ratio. Calculated PAH losses from diffusion and adsorption on the tank walls are well below one percent per day.

Loading the pilot columns with carbon and testing the pilot equipment will be performed by a Calgon field engineer during the period that the carbon in the full-scale adsorbers is being changed. Calgon

Filtrasorb 300 carbon will be used in both the pilot and full-scale columns. This is the type of carbon used during the first two treatment cycles.

## Operation

Operation of the pilot columns will be the responsibility of the City Water Department. Operation of the pilot columns will be checked daily as part of the routine checking of the GAC plant. Flow, pressure and tank level readings will be taken and recorded using the log form presented in Table 3. A copy of Calgon's instruction manual for its pilot column system is provided in Appendix B.

The storage tank and pump to be installed for feeding the pilot columns (see Figure 1) are intended to allow for operation of the pilot columns at a constant rate independent of the full-scale plant operation. Each day the operator will note the storage tank level, open the tank feed valve to fill it, close the feed valve and record the new level. The feed pump for the pilot columns will always be drawing from this tank.

Inlet and outlet pressures for each pilot column will be noted and recorded daily by the GAC plant operator. If excessive pressure drops build up in a column (greater than 10 psi),
it will be backwashed using the procedures specified in Calgon's instruction manual (Appendix B).

## Sampling and Analysis

Samples will be collected by City Water Department personnel according to the schedule given in Figure 2. The sample collection procedures specified in the City's March 1988 Sampling and Analysis Plan will be followed. All samples will be shipped by overnight delivery to

**TABLE 3**
**PILOT COLUMNS OPERATING LOG**

| | | | Pressure Readings, psig | | | | Tank Level Reading | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Date | Time | Flow Reading, gpm | Col.1 In | Col.1 Out | Col.2 Out | Col.3 Out | Initial | Final | Comments | Initials |

Enseco/Rocky Mountain Analytical Laboratory (RMA) for PAH and TOC analyses. PAH analyses will be performed in accordance with the City's March 1988 Sampling and Analysis Plan (i.e., methylene chloride extraction of 4-liter samples with SIM CC GC/MS analysis). TOC analyses will be performed using EPA Method 415.1 (0.1 mg/l detection limit). RMA will attempt to achieve a turn-around time of 20 to 25 days on all samples. Selected split samples will be sent to ERT for PAH and TOC analyses using the same methods as RMA.

## SCHEDULE AND REPORTING

Ordering and delivery of the required new equipment is expected to take 4 to 6 weeks. Installation can be completed in one week. The equipment will be ordered as soon as this plan is approved by the EPA, MPCA and City Project Leaders. These Project Leaders will be notified when the equipment has been installed and when the actual testing is ready to begin. Figure 2 shows that the pilot columns will be operated for 4 to 5 months, depending on the actual breakthrough behavior observed.

Reilly will submit a report on the pilot column test results to the EPA, MPCA and City Project Leaders within 60 days of collecting the last sample from the pilot testing. This report will present all operating and analytical data collected during the test. The report will also present an interpretation of these data with respect to operating practices and carbon lives for the full-scale GAC plant. Calgon Carbon Corp. will provide major support in the data interpretation.

## REFERENCES


Calgon Carbon Corp. 1984. "Evaluation of Granular Activated Carbon for the Removal of Polynuclear Aromatic Hydrocarbons from Municipal Well Water in St. Louis Park, MN." Prepared for ERT, Inc. by Alan J. Roy. September 10, 1984.

Calgon Carbon Corp. 1985. "Accelerated Column Test for Removal of Polynuclear Aromatic Hydrocarbons from Contaminated Groundwater." Prepared for ERT, Inc. by D. L. Mercer. March 8, 1985.

CH2M Hill. 1982. "Evaluation of Groundwater Treatment and Water Supply Alternatives for St. Louis Park, Minnesota." Technical Memorandum Project Element H. Bench-Scale Test Summary Report. December 30, 1982.

CH2M Hill. 1983. "Evaluation of Groundwater Treatment and Water Supply Alternatives for St. Louis Park, Minnesota." Technical Memorandum Project Element K. Pilot Scale Test Summary Report. May 20, 1983.

ERT. 1983. "Recommended Plan for a Comprehensive Solution of the Polynuclear Aromatic Hydrocarbon Contamination Problem in the St. Louis Park Area." Appendix G. Evaluation of Drinking Water Treatment Technologies for PAH Removal. April 1983.

# APPENDIX A

## RTCC SPECIFICATIONS FOR REQUIRED NEW EQUIPMENT

Reilly Tar and Chemical Corporation
Specification for Mechanical Contractor
St. Louis Park Carbon Treater Modifications

I. General conditions and scope of work

a. This contract is subject to Reilly Tar and Chemical Corporation's general conditions of contract which are attached.

b. Work is to be completed on a time and material basis at standard rates.

c. All contractor and subcontractor employees are to comply with all local safety regulations while on the job site.

d. Contractor is to provide all labor, supervision, equipment, and tools required to perform the work listed below. Contractor to provide a new tank (see drawing 880201-140), a pump (see attached specification), a rotameter and a totalizing flowmeter (see attached specifiation). Contractor is to provide all other supplies, including but not limited to piping, valves, fittings, wire, conduit, breakers, and any other required materials.

e. All work is to be done within the limits of the NFPA national electrical code.

f. All work is to be completed by _______________ at 4:00 PM.

II. Contractor is to purchase and install all piping as shown on Reilly Dwg. 880201-300. All piping materials are to be as specified in the attached piping specification. Contractor is responsible for supporting all piping installed by contractor. Flowmeter and pump shown in piping drawing will be provided by Reilly.

III. Contractor is to install one fiberglass tank in the location shown on Reilly Dwg. 880201-300. Tank is to be attached to the concrete floor bv grade ASTM 307 anchor bolts, through mounting lugs provided on tank.

IV. Contractor is to install one inline pump as shown in Reilly Dwg. 880201-300. Contractor should provide an angle iron support beneath the pump.

V. Contractor is to provide 120V, single phase power to one inline pump to be installed by contractor. Power should be taken from existing lighting panel.

VI. Contractor is to purchase and install one sight glass, 3 feet in length (center to center of fittings). Sight glass is to be installed on fiberglass tank described above, on couplings called out as S.G. on Reilly Dwg. 880201-140.

Reilly Tar and Chemical Corporation
Specification for Fiberglass Tank
St. Louis Park Carbon Treater Modifications

Vendor is to provide one (1) fiberglass tank, as shown in Reilly dwg. 880201-140. Tank capacity is to be 1000 gallons minimum. Fiberglass resin used in fabricating tank is to be suitable for benzene storage. Tank is to be steam post cured prior to shipment to prevent plasticizers from leaching into materials stored. Tank is to be equiped with a minimum of 4 galvanized steel tie down lugs. Tank is to be received in St. Louis Park, Minn. no later than ______________.

Reilly Tar and Chemical Corporation
Specification for Pump
St. Louis Park Carbon Treater Modifications

Vendor is to provide a peristaltic pump and motor capable of pumping 0.45 gpm against 10 feet of head. Tubing used in pump is to be suitable for benzene service. Motor is to run off of 120VAC, single phase. Equipment is to be received in St. Louis Park, Minn. by _____________.

Reilly Tar and Chemical Corporation
Specification for Flowmeters
St. Louis Park Carbon Treater Modifications

Vendor is to supply one totalizing flowmeter capable measuring water flow rates of 0.45 gpm at the midrange of the meter. Unit is to require no electrical hookup to operate. Mechanism for total flow readout should be mechanical. Unit is to be received in St. Louis Park, Minn. by ___________.

Vendor is to supply ~~on~~ one rotameter capable of indicating a water flowrate of .45 gpm at the midrange of the meter. Unit is to be received in St. Louis Park, Minn. by ___________.

## VALVES

| TYPE | SIZE RANGE | PRESS RATING | ENDS | BODY MATERIAL TYPE | ASTM No. | ASTM GR. | MANUFACTURER | SERIES OR MODEL No | ADDITIONAL DESCRIPTION |
|---|---|---|---|---|---|---|---|---|---|
| GATE | ½"-1½" | 150 | SCR. | CI | A126 | B | POWELL | 3460 | |
| GATE | 2"-UP | 125 | FLG | CI | A126 | B | POWELL | 1793 | |
| GLOBE | ½"-1½" | 150 | SCR | CI | A126 | B | POWELL | 190 | |
| GLOBE | 2"-8" | 150 | FLG | CI | A126 | B | POWELL | 256 | |
| BALL | ½"-1½" | 2000 | SCR | FS | A105 | — | JAMESBURY | B2236TT | |
| BALL | 2"-8" | 150 | FLG | FS | A126 | — | JAMESBURY | A150F2236TT | |
| PLUG | ½"-1½" | 150 | SCR | CS | A216 | WCB | DURCO | G432 | NON-LUBRICATED |
| PLUG | 2"-4" | 150 | FLG | CS | A216 | WCB | DURCO | G411 | " " |
| PLUG | 6"-8" | 150 | FLG | CS | A216 | WCB | DURCO | G411H | " " |
| CHECK | ½"-1½" | 150 | SCR | CI | A126 | B | POWELL | 1910 | LIFT |
| CHECK | 2"-UP | 150 | FLG | CS | A216 | WCB | CRANE | 147 | SWING |
| BUTTERFLY | 3"-UP | 150 | WAFER | CS | A181 | WCB | HILLS-McCANNA | L150 | |

## PIPE

| SIZE RANGE | PRESS. RATING | ENDS | SCH. | MATERIAL TYPE | ASTM No | ASTM GR. | DESCRIPTION |
|---|---|---|---|---|---|---|---|
| ½"-1½" | — | SCR | 40 | WELDED | A53 | B | |
| 2"-6" | — | BEV | 40 | WELDED | A53 | B | |
| 8"-UP | — | BEV | 10 | WELDED | A53 | B | |

## FLANGES

| SIZE RANGE | PRESS. RATING | ENDS | SCH. | MATERIAL TYPE | ASTM No | ASTM GR. | DESCRIPTION |
|---|---|---|---|---|---|---|---|
| ½"-1½" | 150 | SCR/RF | — | CS | A105 | - | |
| 2"-UP | 150 | SO/RF | — | CS | A105 | - | |
| 2"-UP | 150 | WN/RF | - | CS | A105 | - | |
| 2"-UP | 150 | BLIND/RF | - | CS | A105 | - | |

## STUDS & GASKETS

| TYPE | PRESS RATING | TEMP LIMIT | THICKNESS | MATERIAL TYPE | ASTM No | ASTM GR. | ADDITIONAL DESCRIPTION |
|---|---|---|---|---|---|---|---|
| GASKET | | 270°C | 1/16" | | | | CRANITE |
| STUD | | | | ALLOY | A193 | B7 | |
| NUT | | | | CS | A194 | 2H | |

FORM 91 12/2/82

## FITTINGS

| TYPE | SIZE | PRESS. RATING | ENDS | MATERIAL TYPE | ASTM No. | ASTM GR. | MANUFACTURER | SERIES OR MODEL No |
|---|---|---|---|---|---|---|---|---|
| ELL | ½"-1½" | 150 | SCR | MI | A197 | — | | |
| TEE | | | | | | | | |
| PLUG | | | | | | | | |
| CAP | | | | | | | | |
| CPLG | | | | | | | | |
| UNION | | | | | | | | |
| THREDOLET | | 3000 | | CS | A105 | | | |
| ELBOLET | | | | | | | | |
| LATROLET | | | | | | | | |
| LATERAL | | | | | | | | |
| NIPPLE | | SCH 80 | | | A53 | B | | |
| RED | | 150 | | MI | A197 | — | | |
| ELL | 2"-6" | SCH 40 | BEV | WELDED | A105 | — | | |
| TEE | | | | | | | | |
| RED | | | | | | | | |
| CAP | | | | | | | | |
| ELBOLET | | | | FS | | | | |
| LATROLET | | | | | | | | |
| WELDOLET | | | | | | | | |
| ELL | 8"-24" | SCH 10 | BEV | WELDED | A105 | — | | |
| TEE | | | | | | | | |
| RED | | | | | | | | |
| CAP | | | | | | | | |
| ELBOLET | | SCH 80 | | FS | | | | |
| LATROLET | | | | | | | | |
| WELDOLET | | | | | | | | |

## NOTES

| ISS | DATE | BY | DESCRIPTION | CHK | APR |
|---|---|---|---|---|---|
| I | 12/2/82 | AK | ORIGINAL CERTIFICATION | | |

ANSI RATING: 150#

DESIGN: 180 PSI AT 195 °C

HYDRO TEST: 270 PSI AT AMB °C FOR 15 MIN

GENERAL MATERIAL: CARBON STEEL

SERVICE: COOLING AND FIRE WATER

REILLY TAR AND CHEMICAL CORPORATION

PIPE CLASS B01

# APPENDIX B

# CALGON PILOT FILTRASORB SYSTEM
# INSTRUCTION MANUAL

CALGON CORPORATION

SUBSIDIARY OF MERCK & CO., INC.

# Pilot Filtrasorb System

# INSTRUCTION MANUAL

Code #N-5-092

701118JL

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# 1. INTRODUCTION

## 1.1 DETERMINATION OF DESIGN PARAMETERS FOR A FILTRASORB SYSTEM

If the adsorption isotherm analysis on a waste water sample proves to be feasible in terms of capacity and removing of dissolved organics, the next step in the total study is to determine accurate carbon exhaustion rates and contact time by performing column studies. The column studies can determine several parameters that might have been questioned during the preliminary adsorption isotherm study. Several items of importance that will be analyzed during the column studies are listed as follows:

1.1.1 The determination of an accurate capacity of the carbon to adsorb the particular organics from the waste water.

1.1.2 The determination of the depth of the adsorption zone and total organic carbon wave front profiles which are developed from the column test data. These curves will give a fair estimate of the carbon depth needed to perform the desired function based on the objectives that this system must achieve.

1.1.3 To determine the effect of solids on the activated carbon column system. These observations may suggest that colloidal suspended solids would have to be stabilized and removed from the system prior to applying the water to the carbon columns. Suspended solids in the waste water could also have an adverse effect on the carbon by causing severe clumping.

In this particular case, pretreatment methods may also be examined. The observations could also point out that there would be really no need to go into any expensive pretreatment because the filterability of the granular activated carbon could do the job quite effectively without changing the operating costs drastically.

1.1.4 If the waste being treated is a municipal waste water, there will no doubt be biological activity in the columns. Observations of any by-products from the biological growth on the columns could be beneficial to design. An example could be to determine how hard or how easy the biological suspended solids can be removed from the columns.

1.2 A pilot activated carbon column study is quite a delicate operation. Because of this any difficulties that will be encountered will usually be magnified during the column study. Therefore, any problems encountered, solved and noted will usually be a real asset to the design of the waste water treatment system developed from the data.

## 2. APPLICATION OF PILOT FILTRASORB SYSTEM

### 2.1 SAMPLING AND ANALYSIS FORMAT FOR COLUMN TEST RUNS

To obtain reliable data from a column test run, a procedure to sample and analyze waste water being treated should be followed systematically. The steps which are to follow will outline this general procedure:

2.1.1 Sampling should be at the influent to the columns and the effluent of every column on-stream.

2.1.2 Sample frequency should be every four hours. A composite of the six samples taken each day, should be made each day. Deviation from sampling every four hours is acceptable; however, the exactness of the test results will be reduced. Where waste water concentrations are quite high it may be necessary to sample more frequently than four hours. In these cases it may be desirable not to composite over a day period. This can be left to the judgment of the engineer in charge.

At times it may be desirable to ship the composite samples to the Calgon laboratory for a TOC analysis. Sample vials for this purpose should be obtained from Calgon laboratories. Before shipping, these vials should have the pH adjusted to a value of 2.0 using $H_2SO_4$ (sulfuric acid). This will prevent any biological degradation of the samples while in shipment. Insert aluminum foil under the vial cap before installing the cap.

All the sample vials received from Calgon laboratories will have a "Waste Water Tag" attached by a rubber band. Each vial will also be encased in foam rubber. Before a vial is sent back to Calgon laboratories, the following should be done:

A. Clearly mark the "Waste Water Tag" indicating the analysis to be run, name of company or plant and date.
B. Attach the "Waste Water Tag" using the rubber band. A vial without a tag is of no value.
C. Completely encase the jar in foam rubber.
D. USE CARE IN PACKAGING! Poor packaging leaves many samples broken upon arrival at Calgon Laboratory.

2.1.3 The flow rate through the columns should be checked at least once per day using a timer and a fixed volume container. An example would be to use a one-liter graduated cylinder and a watch. For typical flows used in a column test the results are:

0.25 gpm flow rate - 64 seconds/liter
0.5 gpm flow rate - 32 seconds/liter

2.1.4 The easiest method to analyze the samples taken from a column test run would be to use the TOC (Total Organic Carbon) analysis. However, COD (Chemical Oxygen Demand), $BOD_5$ (Biochemical Oxygen Demand - 5 day) or color can be used to analyze the composite samples taken from the columns. The latter tests take more time and have a larger percentage error than the TOC analysis so are not recommended for the analysis on the composite of the influent and of all columns <u>every</u> day.

The TOC analysis is recommended because it does give an indication of the organic carbon in the waste water. Since the adsorption is of the organics in the waste water, the TOC test fits well in the overall analysis of the column test.

When the final results of the column tests are to be based on $BOD_5$, COD or color, then these tests can be run in conjunction with the TOC test on the influent and effluent from the columns. When this is the case, it is recommended that $BOD_5$ be run every three days, COD run every three days, and color every day on the influent and effluent sample.

Attached is a sample data sheet that can be used to log the data from a pilot test run. For a good test run all the flow and TOC data should

## COLUMN TEST DATA SHEET

| ATE | FLOW RATE (gpm) | ACCUM. FLOW gal/day | TOC mg/l | | | | | BOD$_5$ (mg/l) | | COD (mg/l) | | COLOR (APHA | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Inf. | No. 1 | No. 2 | No. 3 | No. 4 | Inf. | Eff. | Inf. | Eff. | Inf. | Eff |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
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be complete for each day of the test. The $BOD_5$, COD, color, and other data points are to be filled in as it is necessary. Should the plant doing the test work prefer the $BOD_5$, COD or color tests, these parameters can be substituted for TOC values on the data sheet.

Any problems encountered in the application of the Filtrasorb or this system should be forwarded to the Filtrasorb Department at Calgon Center, Pittsburgh, Pennsylvania.

2.2 APPLICATION TROUBLESHOOTING:

2.2.1 PROBLEM

An abnormally high effluent COD.

2.2.1.1 A system that has run for several days may develop a bacteria growth on the carbon much the same as with a trickling filter. If this is the case and the system goes anaerobic, a solution containing methane and hydrogen sulfide could be discharged. The result would be a higher than normal COD on the effluent.

2.2.1.2 Inorganics demanding oxygen could also produce a higher than normal effluent COD.

2.2.2 SOLUTION

2.2.2.1 In the case of where a system could have gone anaerobic causing methane and hydrogen sulfide to be discharged, a simple backwashing of the column will alleviate the problem. To be sure that this does not occur again, the columns should be backwashed once every 24 hours.

2.2.2.2 To be sure that inorganics are not causing a high COD problem, the influent stream should be checked for inorganics that could demand oxygen.

2.2.3 PROBLEM

. Biological growth in the columns.

2.2.3.1 In waste waters which have an organic loading which is readily biodegradable, a biological growth will develop after a few days of operation. The result of the biological growth will be an accumulation of biological solids in and around the granules of activated carbon. If these are not removed periodically, the results will be a clumping and clogging of the filter.

Biological floc growing around the granules of activated carbon will also entrap some colloidal suspended matter which normally might pass right on through the filter media. The overall effect is not known, although adverse conditions could exist from this. In addition, a green algae may appear in the columns due to the action of sunlight on the dormant spores in the waste water.

2.2.4 SOLUTION

2.2.4.1 To reduce the amount of biological solids growing in and around the granular activated carbon, the columns should be backwashed periodically. The backwashing may not necessarily destroy the biological growth but will keep it under control so that the solids system will not be objectionable. Keeping the biological floc under control will also prevent slough-off of biological solids into the effluent giving a turbid discharge from the pilot columns.

2.2.4.2 Algae growth is easily controlled by shielding the columns from sunlight. This may be done by covering columns while outside or moving them inside.

2.2.5 PROBLEM

Suspended solids carrying through the columns.

2.2.5.1 Suspended solids will appear on the influent from any of the columns due to biological activity on the columns or a carrythrough of colloidal suspended materials.

2.2.6 SOLUTION

2.2.6.1 The problem with suspended solids in the effluent of the columns is due to biological activity in the columns. It will be readily visible by viewing the columns. If it is apparent that there is a biological growth on the columns and the results are giving a high suspended solids level on the column effluents, then the columns should be backwashed for at least 10 minutes. This backwashing will free the solids from the granules of carbon and slow the biological growth to the point of where the solids carry over and effluent from the columns will be at a minimum.

2.2.6.2 If the solids that are passing through the filters are colloidal in nature, they will not be removed by the granular activated carbon. These solids can only be handled by properly pretreating the waste water. This can be determined by jar testing the waste water and determining the proper coagulant and/or coagulant aid needed to clarify the water.

## 3. FOUR COLUMN SYSTEM INSTRUCTIONS - 387359

### 3.1 DESCRIPTION

The four column unit is supplied mounted on a sturdy free standing steel frame and is completely piped prior to shipment. A supply of 1/2" OD tubing is supplied for connecting to the sample input, sample output and the backwash drain. In addition, a standard male hose connector is supplied on the backwash inlet to facilitate connecting to a water faucet.

### 3.2 UNPACKING

Examine the unit carefully for any damage which may have occurred in shipment. If any damage is noted, a claim should be filed with the carrier. Calgon will be glad to assist in any way by providing repair estimates, etc.

### 3.3 STARTUP AND OPERATION

3.3.1 The Filtrasorb carbon must be soaked in water overnight before the system can be used. This can be done before or after the carbon is added to the columns.

3.3.2 Remove the top flanges from each of the columns, check to see that the distribution plate is properly located above the discharge part of each column. This plate is a perforated disc designed to allow a uniform distribution of flow through the column.

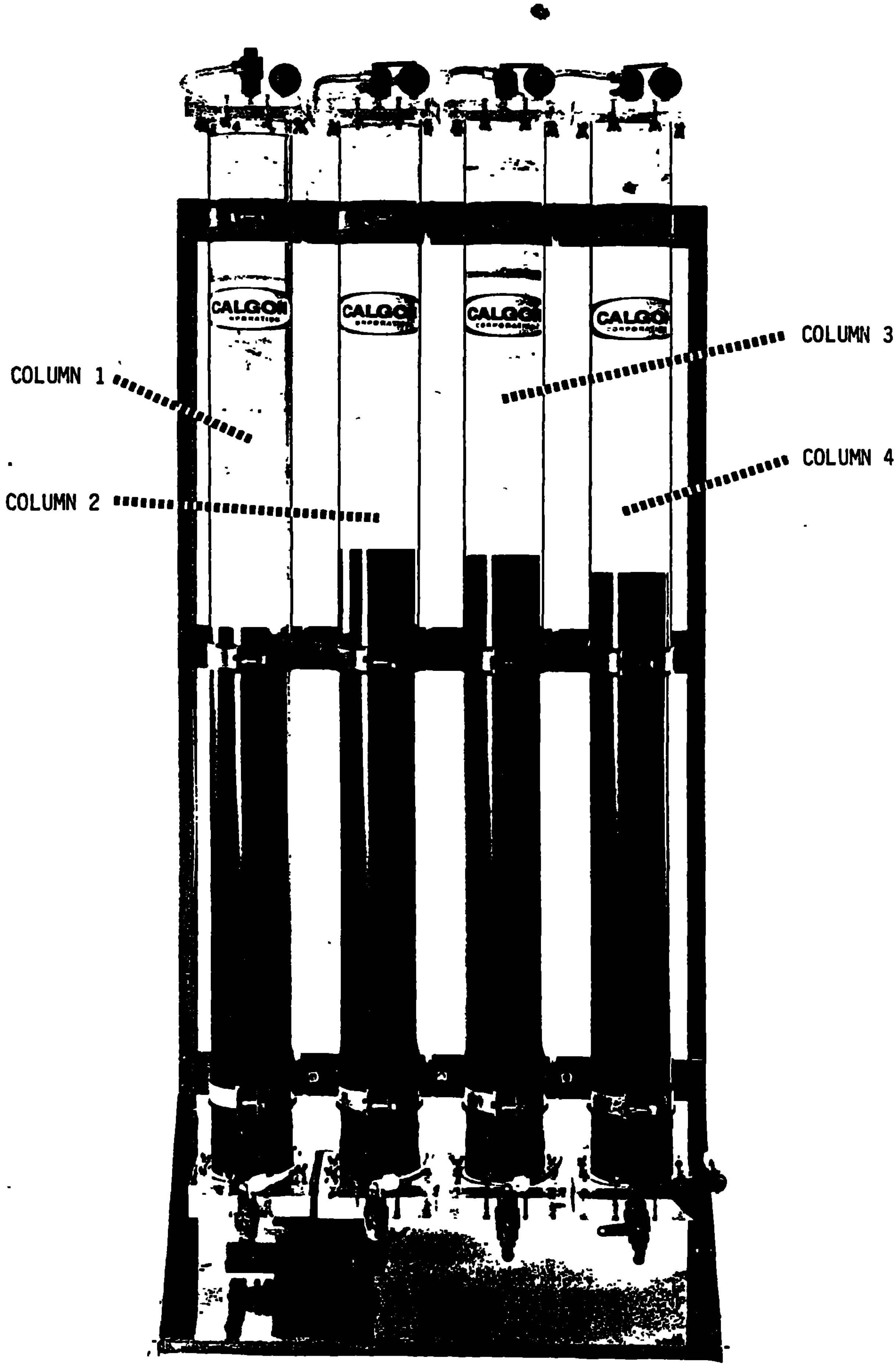
3.3.3 Close the 3-way and 2-way valves at the bottom of the assembly. Refer to Figures 2b, 3 and drawing 287407.

3.3.3.1 Fill each column one-half full of water.

3.3.4 Add 3-4 inches of "pea-size" stones to the column above the distribution plate. (Commercial grade "shot gravel" is ideally suited for this application.) These stones will further ensure a uniform flow distribution.

3.3.5 Prepare a carbon-water slurry which will facilitate adding the carbon to the columns. This can be done by filling a bucket with carbon and slowly wetting it with water from a hose.

3.3.6 Add 3.5 feet of carbon to all four columns. Measure the heights to be sure accurate depths are known for future calculations of capacity.

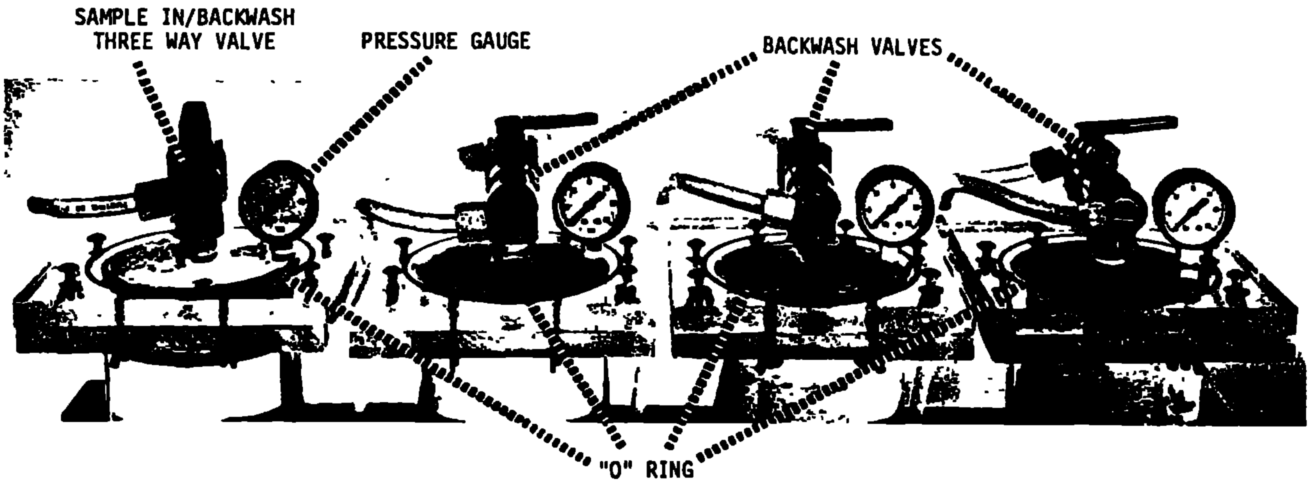



FOUR COLUMN STAND ASSEMBLY
FIGURE 1

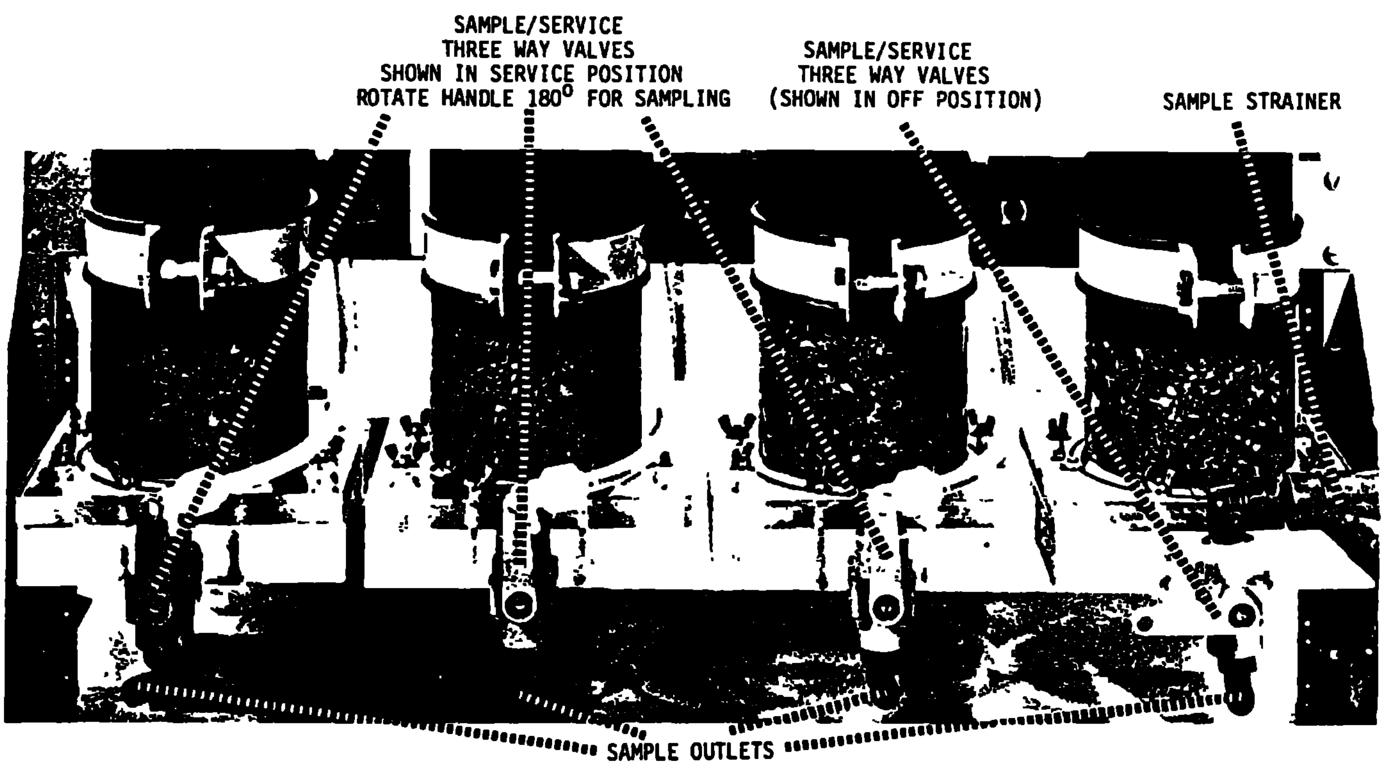
3.3.7 After all the carbon is in the columns, attach the top flanges and check for any leaks. At this time each column should be backwashed for at least 10 minutes. Refer to Figures 2A, 2B, 3 and 7 and drawing 287407 for the necessary valving arrangement. This is done to remove fines and to stratify the beds. Backwash with service (tap) water <u>not waste water</u> at a rate such that carbon is not carried out the discharge port at the top of the column. A 4 gpm flow control valve located in the backwash input line will help ensure a safe flow rate.

3.3.8 After the backwashing is complete and there are no leaks apparent, the unit is ready for operation unless the water soaking is being done in the columns. Then 24 hours must elapse before operation can begin.

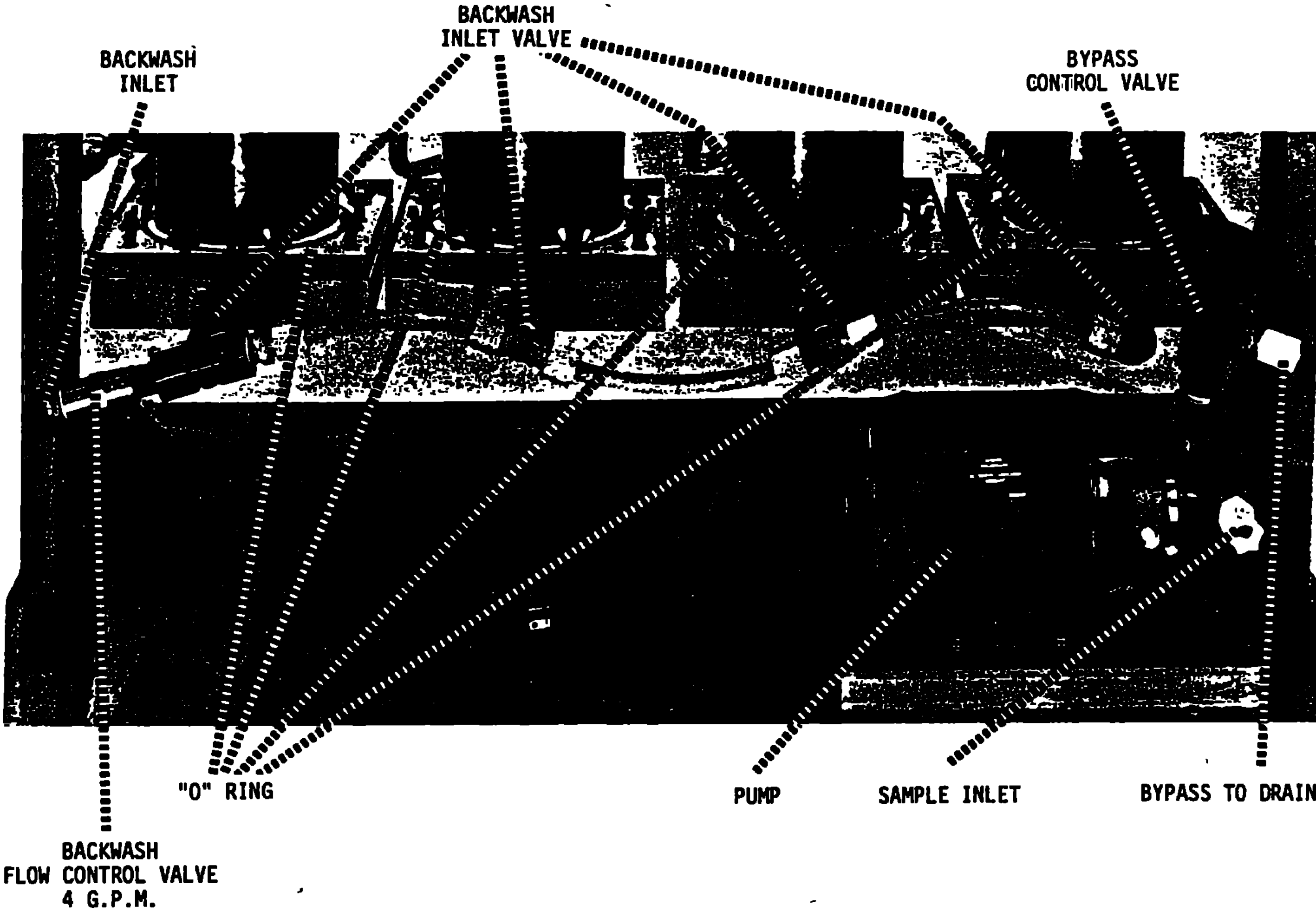
3.3.9 Position the valves for normal service operation. Refer to Figures 2A, 2B, 3 and 8 and drawing 287407. Start the feed pump and percolate waste water through the system. <u>Check to make sure water is flowing through the pump</u>. Damage to the pump can occur if it is run dry for more then 30 seconds. In order to achieve the goal of 0.5 gpm through the system, it will be necessary to set the pressure in Column No. 4 to 10-15 psig. This can be set by using the sample by-pass valve located in the pump discharge line. Because of possible suspended solids in Column No. 1, it will be necessary to set the pressure in Column No. 1 somewhat higher to achieve the 10-15 psig pressure in Column No. 4. Should the pressure drop in Column No. 1 rise above




COLUMN ASSEMBLY TOP
FIGURE 2A




COLUMN ASSEMBLY BOTTOM
FIGURE 2B




COLUMN ASSEMBLY BOTTOM REAR
FIGURE 3

10 psig, the column should be backwashed to remove the suspended solids collected.

In most cases the pressure drop between Columns Nos. 2, 3 and 4 should be negligible. The reason being that the water should be free of suspended solids after the filtering done in the first column.

3.3.1.0 The flow rate is controlled by a flow control valve located in the discharge line from Column No. 4. These valves will plug easily if foreign matter is allowed to pass through the columns. A strainer is installed just ahead of the flow control valve to trap any particles and prevent possible clogging. The strainer can be cleaned by unscrewing the cap as shown in Figure 9.

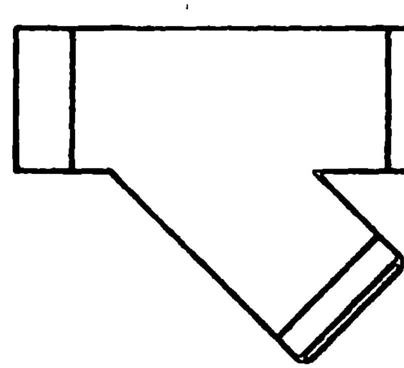
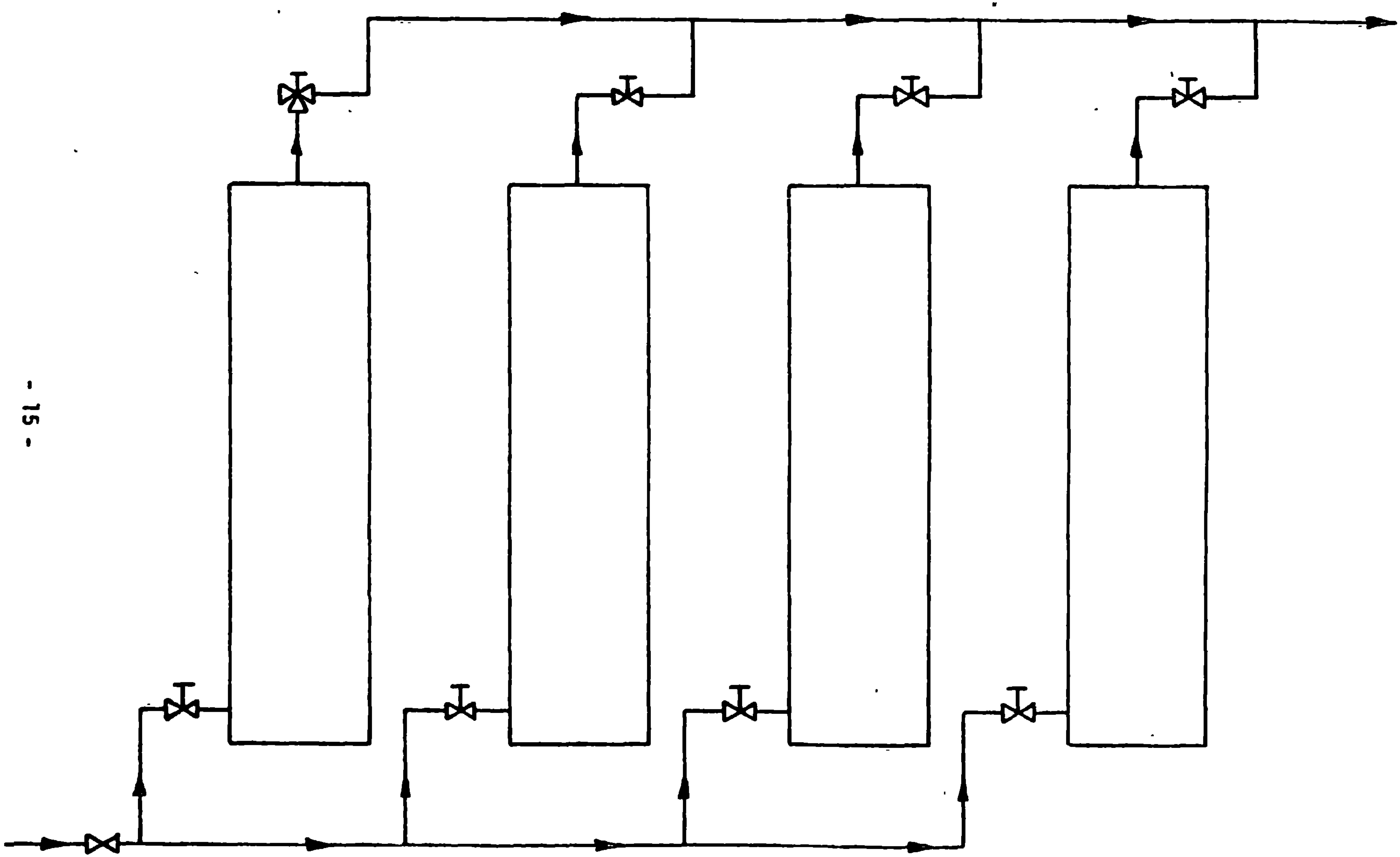
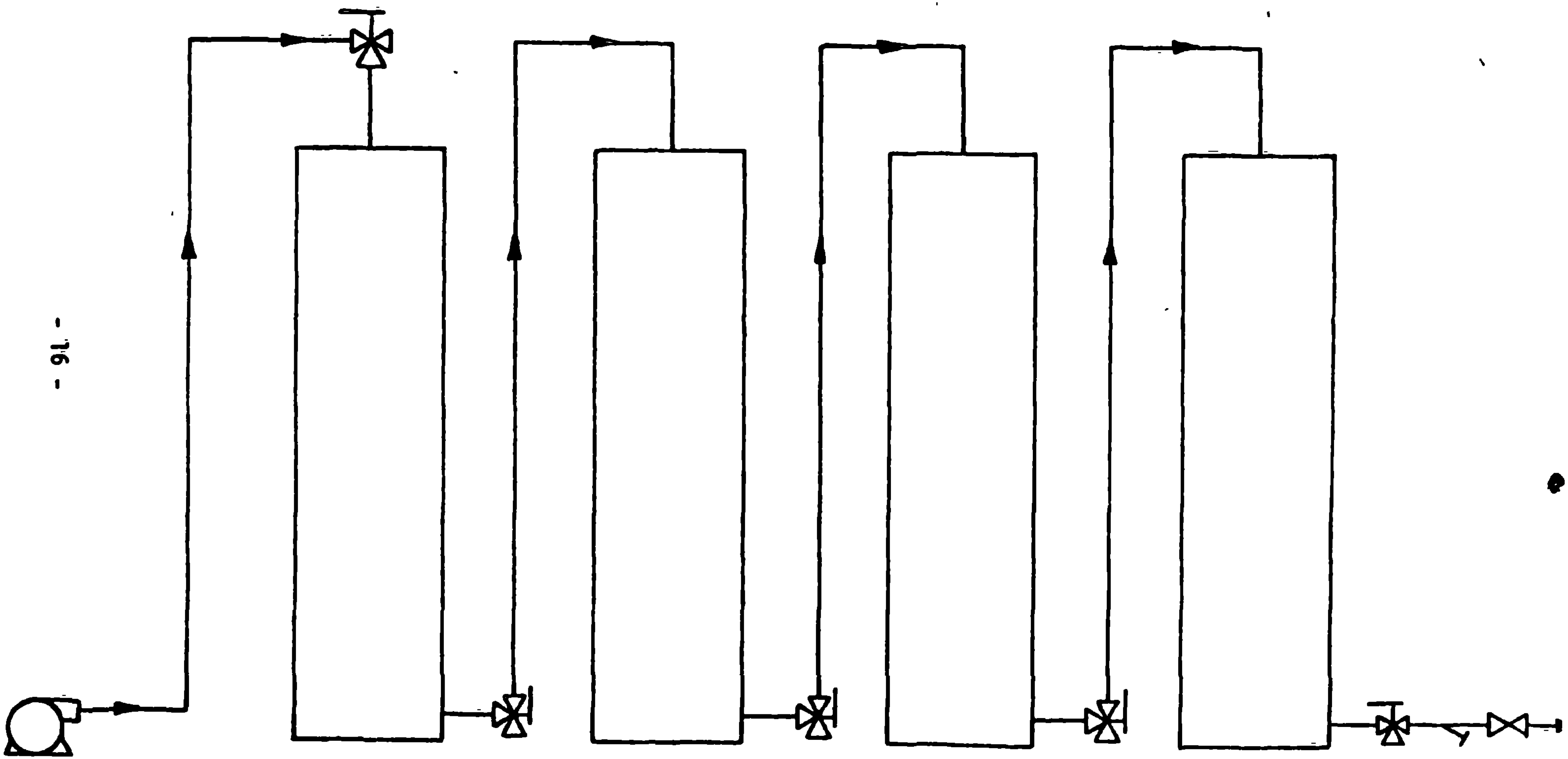



FIGURE 9



BACKWASH FLOW

FIG. 1



SERVICE FLOW

FIG. 8

## 3.4 TROUBLESHOOTING (MECHANICAL)

If the unit does not function properly, first check to see that the valves are in their correct positions for the particular operation you are trying to accomplish. Many seemingly major problems can be caused by a closed valve, pump not plugged in, missing "O" ring in a flange, no sample supply etc., etc. A few minutes checking the obvious sometimes can save hours.

### 3.4.1 PROBLEM

Pump motor operates but does not pump water.

### 3.4.2 SOLUTION

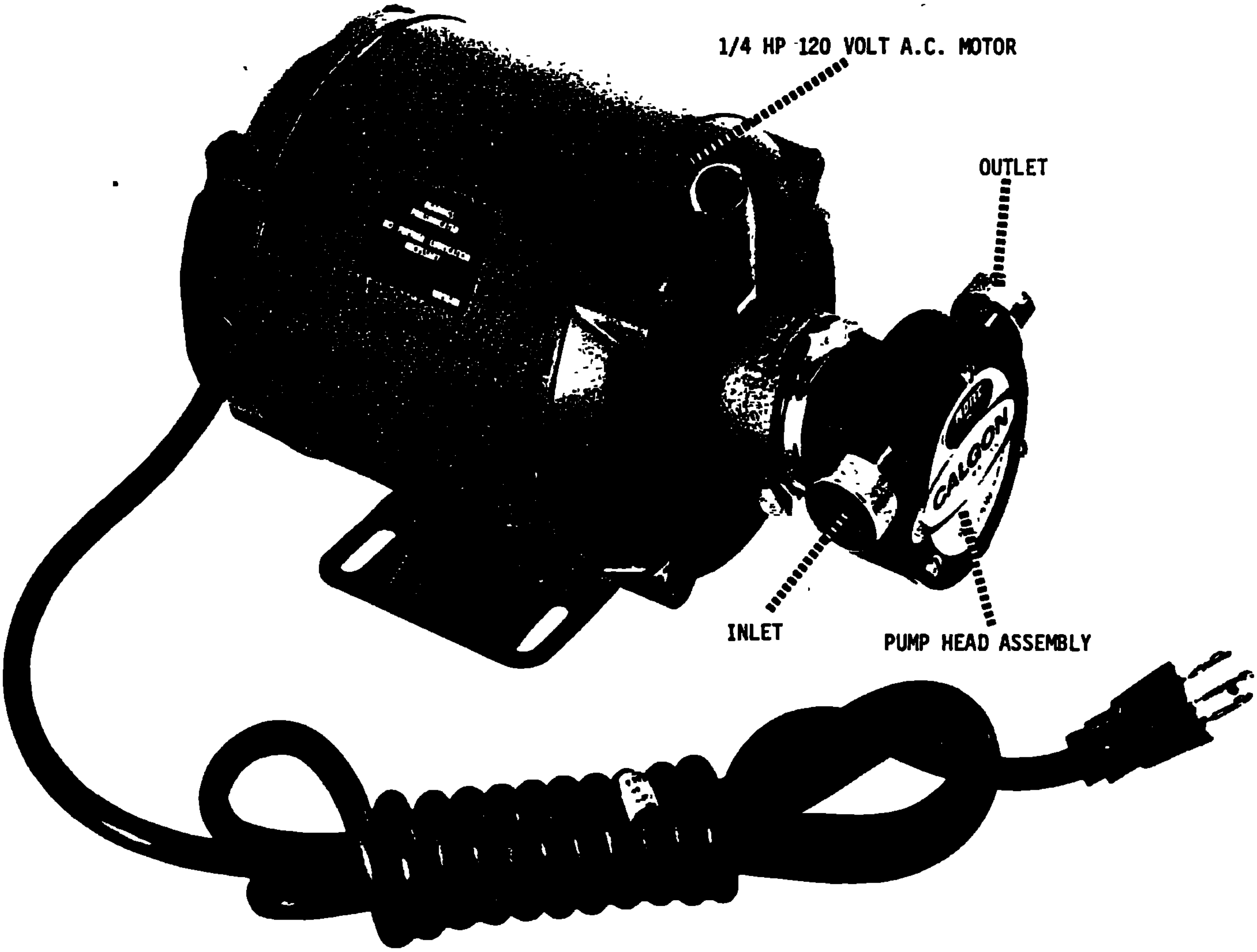
There are several possible causes for this problem. The water supply may be lost due to line plugging or inadequate supply. If possible, locate the suction line in a portion of the stream where the velocity is high enough to prevent solids from settling at the pump suction line.

### 3.4.3 PROBLEM

Carbon beds draining leave activated carbon exposed to atmosphere. This tends to pack the bed leaving channels in and around the carbon. The results will be a channelling effect in the column as the waste water runs through.

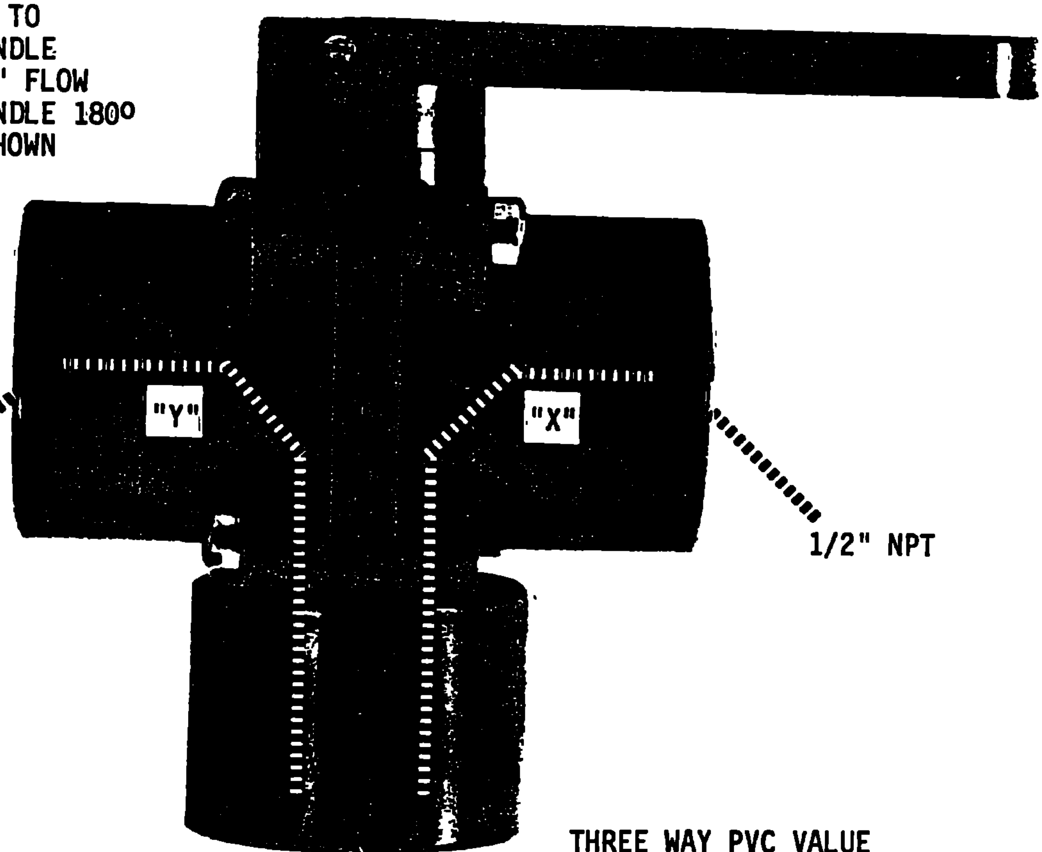
### 3.4.4 SOLUTION

Whenever the carbon column is drained to a point where carbon is exposed to atmosphere, the column must be backwashed for 10 minutes.




SAMPLE PUMP
FIGURE 4

VALVE SHOWN WITH "X", FLOW PATH OPEN, TO CLOSE ROTATE HANDLE 90°, TO OPEN "Y" FLOW PATH, ROTATE HANDLE 180° FROM POSITION SHOWN



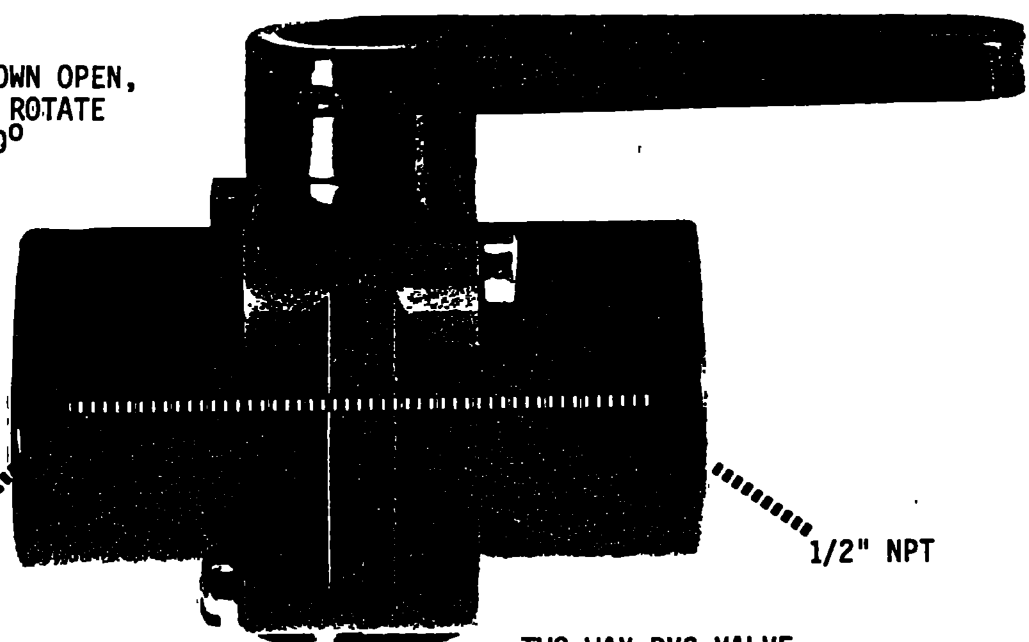

1/2" NPT

1/2" NPT

THREE WAY PVC VALUE

COMMON PORT 1/2" NPT

VALVE SHOWN OPEN, TO CLOSE ROTATE HANDLE 90°



1/2" NPT

1/2" NPT

TWO WAY PVC VALVE

FIGURE 5

The backwashing will tend to loosen packed sections and will stratify the bed to its original position.

3.4.5 PROBLEM

High pressure differential (drop) across a column or columns.

3.4.5.1 Usually the problem causing a high pressure differential is suspended solids in the influent to the columns. This will typically show up in a high pressure differential across Column No. 1.

3.4.5.2 High pressure differential can also be caused by a restriction in the strainer in the sample outlet line.

3.4.5.3 Other potential problem spot where clogging could occur is at the discharge port of any of the columns.

3.4.6 SOLUTIONS

3.4.6.1 If the problem is due to suspended solids in the first column, the solution would be to backwash that column for at least 10 minutes with service water.

3.4.6.2 If the problem is a clogged strainer, the pressure in Column No. 4 will be essentially the same as the pressure in Column No. 1 and very little, if any, flow will be coming out the discharge line. The strainer is easily cleaned as described in Part 3.3.1.0, Page 14, Figure 9.

3.4.6.3 If the high pressure drop is due to clogging in any of the other columns in the system, the trouble can be localized by following the pressures on the top of the columns through the system. For instance, if the pressure on the top of Column No. 3 is the same as the pressure on the top of Column No. 1 and the pressure on the top of Column No. 4 is much lower, it can be assumed that there is plugging in Column No. 3 or its discharge port. These plugs can only be found and corrected by removing piping and further checking.

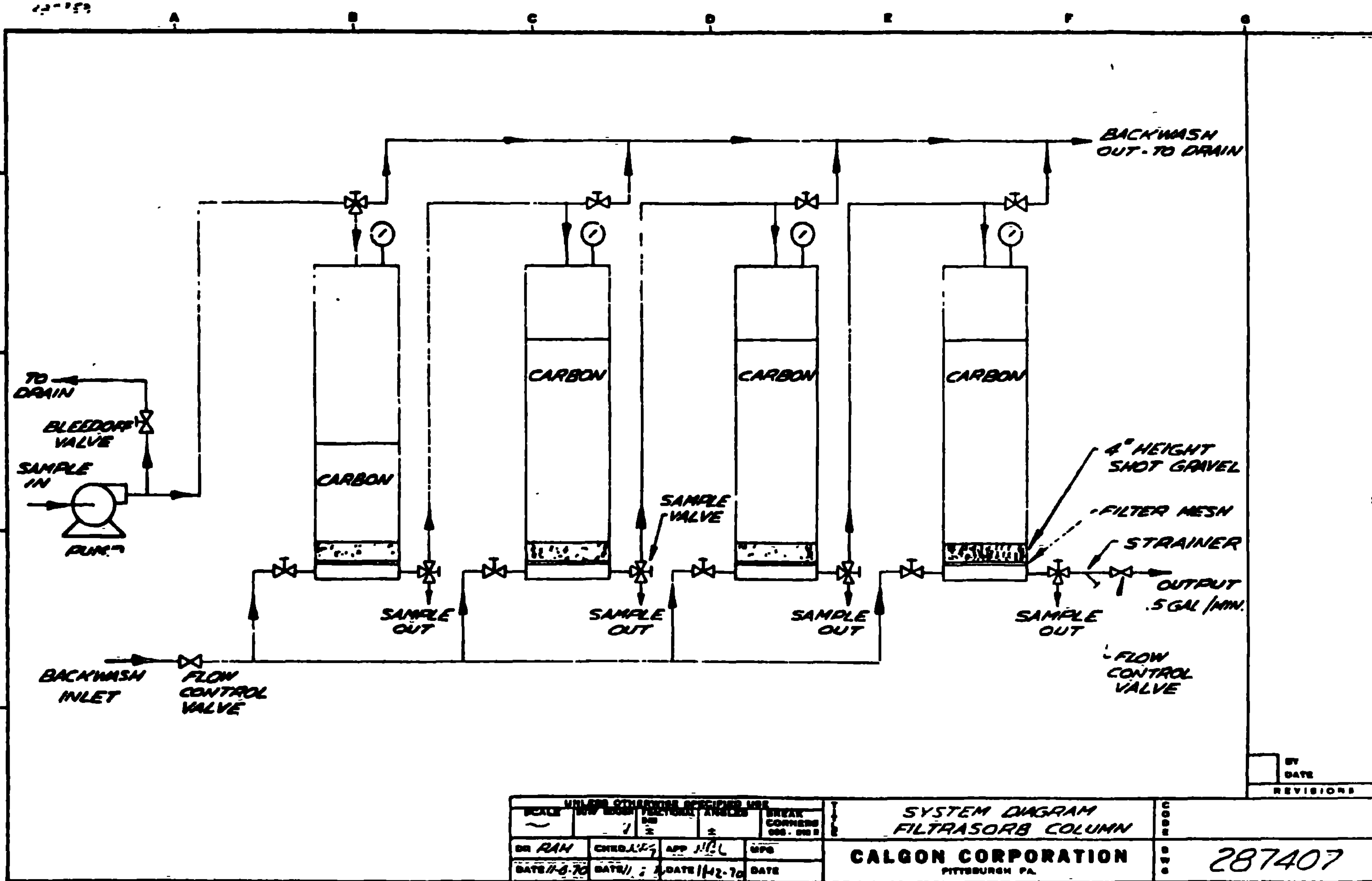
## SPARE PARTS

## FOUR CARBON COLUMN SYSTEM

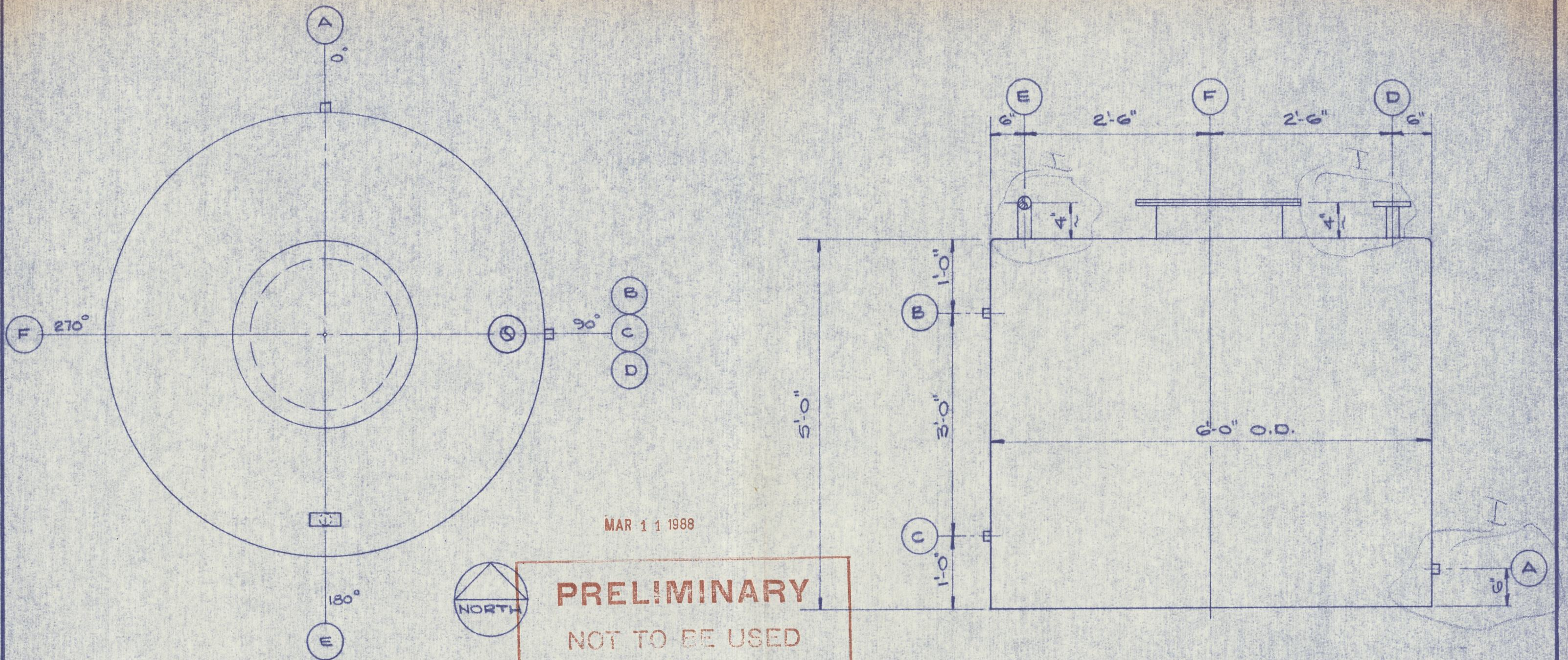
| CATALOG NO. | DESCRIPTION |
|---|---|
| 3500-8600-5 | "O" Ring, Column Flanges 6 x 6-1/4 x 1/8 |
| *3500-8619-6 | "O" Ring, Column Flanges 6 x 6-3/16 x 3/32 |
| 3500-8601-3 | Pump (Complete With Motor) |
| 3500-8602-1 | Pump Service Kit |
| 3500-8603-0 | Pump Head Assembly |
| 3500-8604-8 | Pump Impeller |
| 3500-8605-6 | Pump "O" Ring |
| 3500-8606-4 | Flow Control Valve 1/2 gpm |
| 3500-8607-2 | Flow Control Valve 4 gpm |
| 3500-8608-1 | Pressure Gauge |
| 3500-8609-9 | 3-Way PVC Ball Valve |
| 3500-8610-2 | 2-Way PVC Ball Valve |
| 3500-8611-1 | 1/2" OD Polyethylene Tubing |
| 3500-8612-9 | Polypropylene Elbow 3/8 NPT x 1/2 Tube |
| 3500-8613-7 | Polypropylene Male Connector 1/2 NPT x 1/2 Tube |
| 3500-8614-5 | Polypropylene Elbow 1/2 NPT x 1/2 Tube |
| 3500-8615-3 | Polypropylene Male Branch Tee 1/2 NPT x 1/2 Tube |
| 3500-8616-1 | Column Tube |
| 3500-8617-0 | Column Top Flange |
| 3500-8618-8 | Column Bottom Flange |
| *3500-8620-0 | PVC Reducing Bushings 1/2 x 3/8 NPT |
| *3500-8621-8 | PVC Close Nipple 3/8 NPT |

*These parts are used on units with no suffix letter in the serial number.

387359


BACKWASH OUT-TO DRAIN
TO DRAIN
BLEEDOFF VALVE
SAMPLE IN
PUMP
CARBON
CARBON
CARBON
CARBON
SAMPLE VALVE
4" HEIGHT SHOT GRAVEL
FILTER MESH
STRAINER
OUTPUT .5 GAL/MIN.
SAMPLE OUT
SAMPLE OUT
SAMPLE OUT
SAMPLE OUT
FLOW CONTROL VALVE
BACKWASH INLET
FLOW CONTROL VALVE
REVISIONS
SYSTEM DIAGRAM
FILTRASORB COLUMN
CALGON CORPORATION
PITTSBURGH PA.
287407
DR RAH
DATE 11-6-70
PRINTED IN U.S.A.

GENERAL NOTES




MAR 1 1 1988



| DWG NO | REF DWG/DESCRIPTIONS |
|---|---|
| | |
| | |
| | |
| | |
| | |

PHOTOSTAT DATE:

MICROFILM DATE:

| ISSUE | DATE | BY | REVISIONS/DESCRIPTION | CHKD | APVD |
|---|---|---|---|---|---|
| I | 3/11/88 | AK | CHANGE NOZ. HEIGHTS & NOZ (A) TO CPLG | [illegible] | DWB |

| CONN | SIZE | SCHED W THK | RATING/TYPE | FACE | REINF RING DIA x THK | PJTN | QTY | DET | DESCRIPTION |
|---|---|---|---|---|---|---|---|---|---|
| F | 24" | | 150# | | | 6" | 1 | | MANWAY |
| E | 2" | | 150# | | | 6" | 1 | | VENT |
| D | 2" | | 150# | | | 6" | 1 | | INLET |
| C | 1" | | CPLG | | | | 1 | | SIGHT GLASS |
| B | 1" | | CPLG | | | | 1 | | SIGHT GLASS |
| A | 1" | | CPLG | | | | 1 | | DRAIN |

CONNECTION SCHEDULE

| DESIGN DATA | |
|---|---|
| WT EMPTY | |
| WT FULL W/ WTR | |
| CAP | |
| INSUL | |
| PAINTING | |
| HYDRST TEST PRESS | |
| RAD INSP | |
| STRESS RLF | |
| JT EFF | |
| CRSN ALLOW | |
| OPR TEMP | |
| OPR PRESS | |
| DSGN TEMP | |
| DSGN PRESS | |
| CODE STP REQD | |

DESIGN DATA | DSGN CODE

| MATERIAL SPECIFICATIONS | |
|---|---|
| PIPE (INTL) | |
| NUTS (INTL) | |
| BOLTS (INTL) | |
| PLATE (INTL) | |
| STRL SHPS (INTL) | |
| NUTS (EXT) | |
| BOLTS (EXT) | |
| PLATE (EXT) | |
| STRL SHPS (EXT) | |
| GSKTS | |
| REINF RINGS | |
| CPLGS | |
| MANWAY FLG | |
| MANWAY NECK | |
| NOZ FLGS | |
| NOZ NECKS | |
| TYPE OF HEAD | |
| HEAD | |
| SHELL | |

MATERIAL SPECIFICATIONS

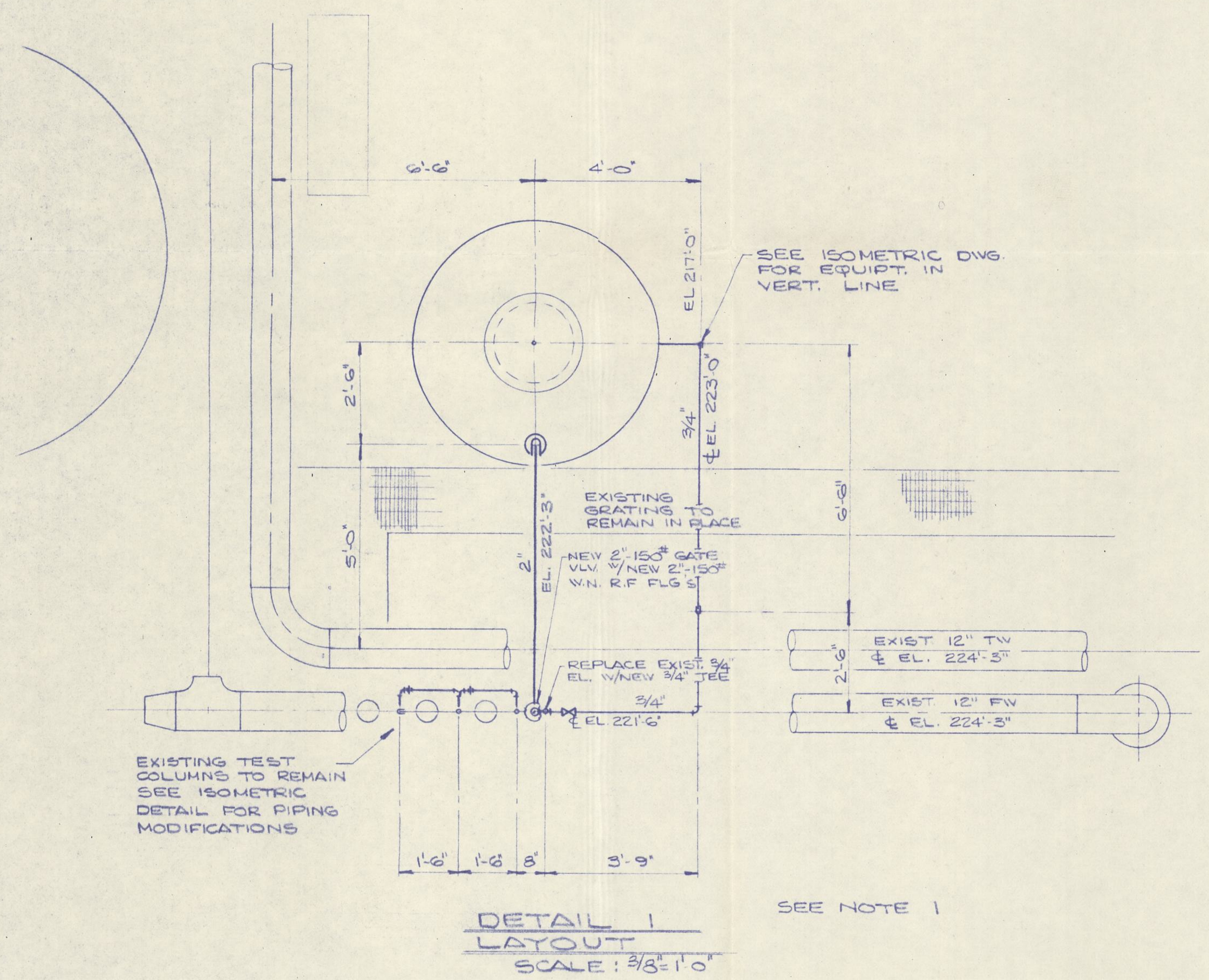
REILLY TAR & CHEMICAL CORPORATION
INDIANAPOLIS, INDIANA

TITLE CARBON TREATMENT SYSTEM MODIFICATIONS - STORAGE TANK

| DWN | DATE | CHKD | DATE | APVD | DATE |
|---|---|---|---|---|---|
| AK | 2/22/88 | [illegible] | | DWB | Feb 21, 88 |

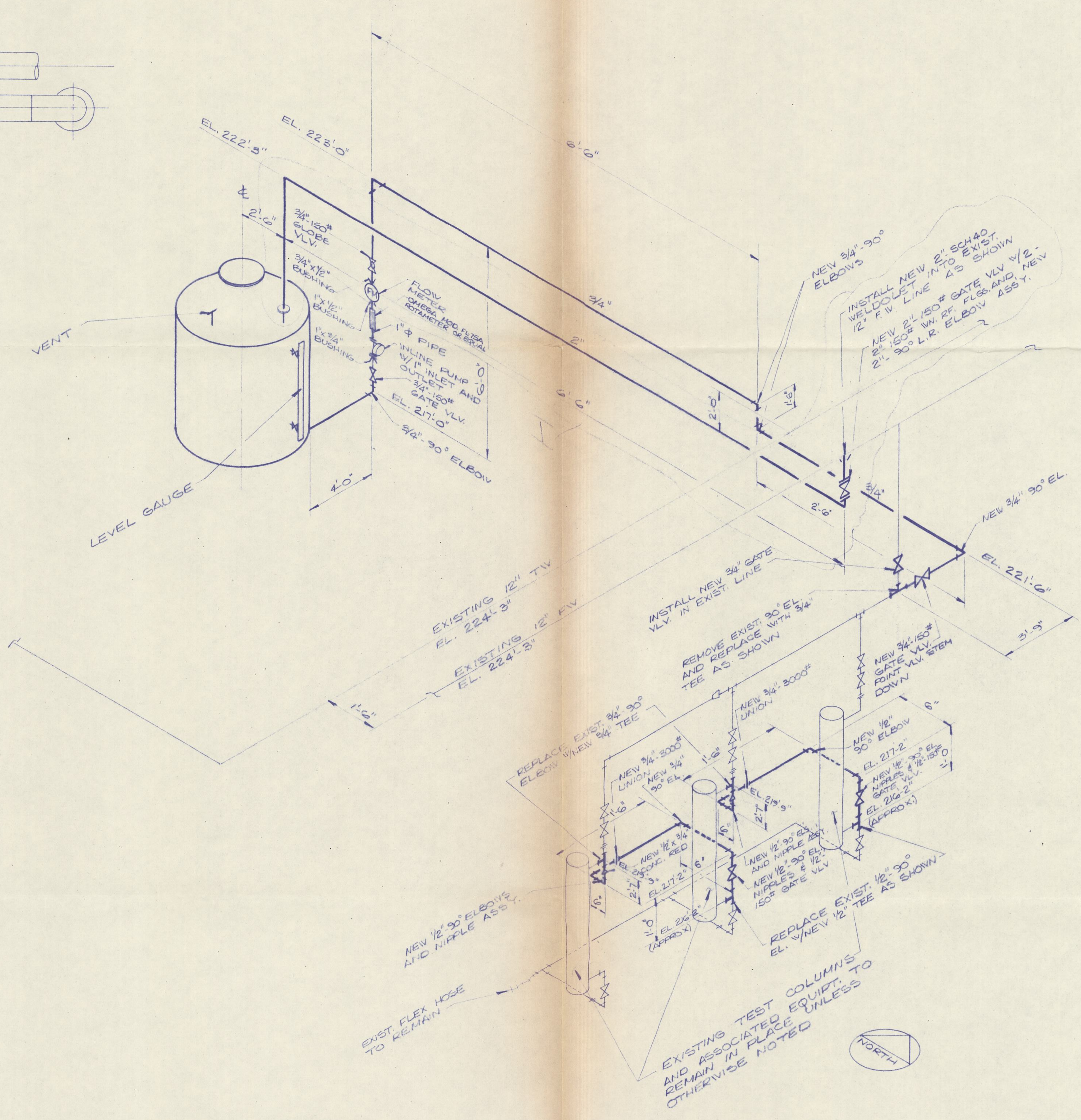
| SCALE | PLANT | DWG NO | ISSUE |
|---|---|---|---|
| 3/4" = 1'-0" | ST. LOUIS PARK, MINN. | 880201-130 | I |
| PO NO | EQPT NO | | |

MARBAUGH




DETAIL 1
LAYOUT
SCALE: 3/8"=1'-0"

SEE NOTE 1




DETAIL 2
ISOMETRIC LAYOUT
NO SCALE

NOTES:

1. ALL DIMENSIONS ARE APPROXIMATE AND MUST BE FIELD CHECKED BEFORE ANY SHOP FABRICATION OR CONSTRUCTION
2. BOLD LINES (——) INDICATE NEW EQUIPMENT OR PIPING, LIGHT LINES (——) INDICATE EXISTING EQUIPT. OR LINES TO REMAIN IN PLACE

MAR 11 1988

PRELIMINARY
NOT TO BE USED
FOR CONSTRUCTION
REILLY TAR & CHEMICAL CORP.

| PHOTOSTAT | DATE: |
|---|---|
| MICRO FILM | DATE: |

REVISIONS

| NO. | DATE | BY | DESCRIPTION | CHK'D | APP'D |
|---|---|---|---|---|---|
| I | 8/11/88 | AK | RELOCATED 2" FILL LINE FROM T.W. TO F.W. | | |

REFERENCE DRAWINGS

| DRAWING NUMBER | DESCRIPTION |
|---|---|
| | |

**REILLY TAR & CHEMICAL CORPORATION**
INDIANAPOLIS INDIANA

CARBON TREATMENT SYSTEM MODIFICATIONS

| DRAWN BY | DATE | CHECKED BY | DATE | PLANT | REVISION |
|---|---|---|---|---|---|
| AK | 2/22/88 | | | ST LOUIS PARK, MINN. | I |
| SCALE | | APPROVED BY | DATE | DRAWING NUMBER | |
| INDICATED | | | | 880201-300 | |